Incorporating Rice Coffee as an Alternative Flavor to Traditional Muffins

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Chapter I

This chapter is the introduction of the study including background of the study, statement of the problem, objectives of the study, hypothesis, scope and limitations, significance of the study, and definition of terms.

Introduction

The growing demand for food options has prompted the food industry to creatively incorporate nutritious foods ingredients into familiar meals. Muffins, traditionally sweet, individually-sized quick breads, are commonly enjoyed at breakfast or as snacks. Typically made with a batter containing flour, sugar, eggs, and baking powder, muffin can be customized with various ingredients such as milk, butter, or vegetable oil and come in flavor like blueberry, chocolate chip, and banana nut.

While many people love coffee, some cannot consume it due to caffeine sensitivity. This study explores rice coffee as an alternative. Made by toasting rice grains until they become brown and then brewing them like traditional coffee, rice coffee has a nutty, roasted flavor without caffeine, making it an excellent choice for those seeking options. Researchers plan to assess whether rice coffee can serve as a flavoring for muffins. By replacing regular coffee or artificial flavors with rice coffee in the batter, they aim to evaluate its effect on the taste, aroma, and texture of the final product. Given that rice is more affordable and widely available than coffee, this could lead to delicious yet budget-friendly muffins. If successful, this innovation could introduce a new health-conscious flavor to baked goods.

The study's focus is understanding consumer acceptance of rice coffee in muffins compared to traditional varieties. Researchers will examine whether people are receptive to the unique attributes of rice coffee, including its distinct taste and aroma, while considering the familiar qualities of conventional muffins. This exploration aims to discover if rice coffee muffins can maintain the expected sensory appeal while carving out a niche in a competitive market. In analyzing consumer responses, the study will evaluate key features such as flavor, texture, and aroma, aiming to determine whether this new approach stands out among baked goods. By investigating these aspects, the research seeks to promote rice coffee muffins as a flavorful and appealing option.

Statement of the Problem

This study aims to determine the acceptability on consumers' preference of incorporating rice coffee into muffins. Specifically, if it seeks to address the following questions:

1. What is the level of consumers' acceptability on rice coffee as an alternative flavor of muffin in terms of smell, taste, and texture?

2. What is the prevalence of consumer interest in muffin alternatives that contain rice coffee?

3. Is there a significant difference of incorporating rice coffee into muffins compared to regular muffins?

Objectives of the Study

1. What is the level of consumers' acceptability on rice coffee as an alternative flavor of muffin in terms of smell, taste, and texture?

2. To determine consumer interest in muffin alternatives that contain rice coffee.

3. To compare the difference between rice coffee muffins and regular muffins in terms of consumer preference and sensory attributes.

Hypothesis

H_1 : There is a significant difference in taste, aroma, and texture between rice coffee muffins and regular muffins.

Scope and Limitation

This study will be conducted at STI College, located in [redacted], using convenience sampling, where 10 volunteers from each section of the senior high school department will be selected. The study aims to determine the prevalence of consumer interest in muffin alternative containing rice coffee. It will also assess the level of consumer acceptability of rice coffee as an alternative muffin flavor in terms of smell, taste, and texture. Additionally, the study will examine whether there is a significant difference between muffins with rice coffee and regular muffins. However, the study is limited by factors such as the type of rice available, the short time frame for research, and the local resources and materials that will be used. This approach allows for efficient data collection while providing valuable insights into consumer perception, preference, and interest in rice coffee as a muffin ingredient.

Significance of the Study

The results of the study will be of great benefit to the following:

Students – It can help to further enhance the awareness of a student about an eating habit and encourage them to make food choices in their daily lives.

Teachers – It can inspire teachers to encourage their students to explore more creative ways in making their favorite food. This study can also be used as an example to teach students about the importance of a nutritious and well-balanced diet.

Parents and Guardians – Parents can use this study to make a nutritious and tasty snack for their family as an alternative to the traditional muffin. It is also a good and creative way to interduce healthy snack to their kids as it is much easier to include it in the children's nutritious meal.

Food Manufacturers – This study can be used by food manufacturers as a basis to develop new products. Companies in the food industry, particularly those that produce or make muffin and other snack products can use this study to cater to the increasing demand for and plant-based alternatives.

Future Researchers – The findings of this research will serve as a foundation for future studies. Future researchers can use the methods, results, and conclusions to explore new ideas to improve and developed various ways to make a snack more nutritious. They may find inspiration to conduct their own experiments, particularly in the field of nutritious food alternatives.

Definition of Terms

Caffeine-free – means that there was never any caffeine in the product.

Flavor – the distinctive taste of a food or drink.

Metabolism – the chemical reactions in the body's cells that change food into energy. Our bodies need this energy to do everything from moving, thinking, and growing.

Muffin – an individually portioned baked product, however, the term can refer to one of two distinct items: a part-raised flatbread (like a crumpet) that is baked and then cooked on a griddle (typically unsweetened), or a quick break (often sweetened) that is chemically leavened and the baked in a mold.

Rice grains – often characterized as one of three varieties – long, medium, or short rice grains, which refers to the length and shape of the grain. The grain size affects the texture of the rice, therefore long grain, medium grain, and short grain rice are all used for different cooking applications.

Rice coffee – roasted rice coffee is a healthy non-caffeinated drink. It is filled with antioxidants, phytic acid that prevents colon cancer, cleans and purifies the blood, promoting blood circulation, calming effect promotes healthy digestion. It's also gluten free, easy to make and cheap.

Prevalence – percentage or proportion of people who shows interest in muffins.

Chapter II

This chapter includes local and foreign review of related literature and studies, synthesis, theoretical framework, and conceptual framework.

Review of Related Literature and Studies

Local Literature

According to Bocog and Paradero (2023), rice bran has shown great potential in food applications due to its high health beneficial components. In the Philippines, however, using fermented rice bran as a supplemental ingredient to foods is a new product concept. Incorporating fermented rice bran to bakery products requires prior market information such as consumers' perceptions and purchase intentions toward the new product to increase the chance of the new product's market success.

As reported by Caday et al. (2021), rice grain (Oryza sativa), is the staple food crop in the country, and Filipinos are consuming it not just for food but also for beverages, where literature shows that caffeine consumption in the country rapidly increasing compared to the past decade. One of the potential coffee alternatives is roasted rice grains, which can be turned into a coffee-like beverage but caffeine-free.

In agreement with Asuncion et al. (2024), rich coffee is particularly known in Asia where there is a rich source of rice. It is made from roasted rice and is from the context of a global shift toward healthier options for beverages. This highlights the advantage of rice coffee as an alternative to instant coffee. This research aims to improve the production and formulation of rice coffee, making it a viable and appealing alternative to instant coffee.

According to Morales et al. (2022), toasted rice grains are known to be an alternative to commercialized coffee, these alternatives are usually for those who are acidic as rice coffee doesn't cause acid reflux. Nutritionally, brown rice is recommended for a healthy diet because it contains extra nutrients. Brown rice tends to be a bit more caloric, but it also contains extra protein and fiber that offers health benefits. Brown rice coffee is one of the best coffees' substitutes you will ever find. It is healthy, natural, sugar-free, and caffeine-free.

Foreign Literature

In consonance with Adawiyah et al. (2022), coffee is a drink that is popular with many people. However, some people have a sensitivity to the caffeine contained in coffee. In addition to caffeine, coffee also contains acids that can be bad for health. Rice coffee is rice that goes through a roasting process to produce a taste that resembles coffee. Coffee made from rice does not contain caffeine and is not acidic, so it is safe for those with sensitive stomach.

Based on Shukla et al. (2024), the percentage of bakery products in total food consumption is very high, and soft bakery foods despite having a short shelf life, are liked because of their deliciousness. Recent research studies have extensively covered the use of various fruits, vegetables, grain, and their by-products as raw materials and value-added incorporation in the muffin to produce a nutrient-rich and highly valuable muffin.

As explained by Chu et al. (2023), the quality characteristics of muffins with different types of rice flour, such as soft flour (CON), soft rice flour (SRF), floury rice flour (FRF), and rice flour (RF) were assessed by using Image-J program, which includes their particle size analysis, moisture content, pH, color, specific volume, baking loss rate, and texture.

As indicated by Lee et al. (2023), the effects of tigernut dietary fiber inclusion in rice muffin formulations on the functional and pasting properties of composite powders, as well as the nutritional and sensory properties of muffins were investigated. The gluten in wheat flour is a type of insoluble protein composed of glutenin and gliadin, which helps dough rise and gives a chewy texture. To make gluten-free muffins, they replaced the wheat flour with rice flour and added tigernut insoluble dietary fiber (TDF) to compensate for the nutritional limitations of rice flour.

According to Rios et al. (2020), this study aimed to assess the physiochemical, nutritional and sensory properties of gluten-free breads containing isolated coffee cascara dietary fiber (ICCDF) as a food ingredient. Gluten-free bread formulations were prepared enriching a commercial bakery premix in rice protein (8%) and ICCDF (3% and 4.5%). In conclusion, a certificated gluten-free bread with improved nutritional and physiochemical properties and good sensorial profile was obtained.

As said by Aguilar et al. (2023), the spent coffee grounds (SCG) obtained from light roasting had a higher content of total phenolic content, chlorogenic acid (5-CGA), trigonelline, caffeine, and great antioxidant activity than the SCG obtained from dark roast. However, the color and hardness of the SCG-added muffins changed. Although the addition of these by-products to muffins does not affect the characteristics, such as the cohesiveness, chewiness, and elasticity, and results in enrichment of the caffeine, trigonelline, and chlorogenic acid contents, the addition of percentages close to the CAT is recommended to ensure consumer acceptance of the product.

According to Kaur et al. (2021), muffins are composed of wheat flour, eggs, sugar, shortenings or oil, and milk which make them unsuitable for patients suffering from diabetes, and coeliac disease, therefore, reduction in sugar levels, increase in protein content and making gluten-free muffin making potential of DF-RB from brown rice of both cultivars milled to 2% and 8% DoM was also evaluated in present study.

According to Lima et al. (2024), gluten-associated enteropathies have been on the agenda today. With this, the food industry shows interest in adapting conventional foods made with wheat flour to gluten-free flour to meet this market niche. Thus, this work evaluated the physiochemical and proximate characteristics of the dough and muffin-type cake using whole meal rice, red sorghum and carioca bean flours.

As believed by Amorim et al. (2021), innovation of pastry products towards higher nutritional and commercial value remains a challenge to the growing field of healthy food. Rice muffins containing 100% of sugar or 75% of sugar supplemented with 0.8% GOS were produced and compared with commercial rice muffins regarding their physical and textural properties. Textural results indicate that springiness and resilience of the muffin with low sugar content are acceptable, but hardness and chewiness were increased.

According to Pruett et al. (2023), muffins made from the whole-grain sorghum flour used in their study fell in the GI range of low to intermediate, depending on the particle size of flour used. When compared to other grains tested, sorghum products from intermediately ground flour exhibited a significantly lower glycemic response, with the exception of brown rice flour. These results can assist in the product

development process to advance the quality of healthy, gluten-free, sorghum-based foods for consumers.

Synthesis of the Art

The reviewed literature and studies provide significant insights into the potential of rice coffee muffins as a functional and innovative food product. Both local and foreign sources highlight key aspects such as the nutritional benefits of rice-based baked goods, the viability of rice coffee as an alternative to traditional coffee, and consumer acceptability of healthier bakery products.

Several foreign studies emphasize the benefits of using rice flour as a primary ingredient in gluten-free muffins. These researches suggest that rice-based muffins offer improved nutritional value, better texture, and enhanced antioxidant properties. These findings align with local studies in the Philippines, such as the research on fermented rice bran, which highlights the growing market for rice-based baked goods.

Studies show that rice coffee is gaining popularity as a caffeine-free coffee alternative. Local research, such as then study on roasted Charice Maharlika rice beverage, supports the potential of rice coffee as a flavorful and nutritious ingredient. Similarly, foreign literature on coffee cascara dietary fiber and spent coffee grounds in muffins suggest that coffee-related ingredients can improve the functional properties of bakery products.

Both local and foreign studies indicate strong consumer interest in alternative food products. Local studies, such as the research on consumer willingness to buy fermented rice bran bakery products, suggest that rice-based products are well-received in the Philippine market. Foreign studies on teff flour-enriched rice muffins and the glycemic index of rice flour muffins further emphasize the demand for functional and nutritious baked goods.

Studies on muffins and alternative ingredients, such as those by Shukla et al. (2024), highlight the growing interest in incorporating various natural ingredients to improve the nutritional content and consumer appeal of baked goods. Rice coffee could fit into this trend by adding a distinct flavor while keeping the product light and nutritious.

These studies of Lee et al. (2023), show how adding fiber-rich ingredients, like tigernut fiber, can boost the health benefits of muffins. Similarly, rice coffee could provide antioxidants, which help in protecting the body from harmful substances, and other nutrients that support overall wellness. In this way, rice coffee can be viewed not only as a flavor enhancer but also as a functional ingredient, enriching muffins with health benefits similar to those seen in other alternative ingredients.

The synthesis of these studies supports the feasibility of rice coffee muffins as a unique and health-conscious bakery product. The nutritional benefits of rice, the sensory appeal of rice coffee, and the increasing consumer interest in alternative baked goods all point toward the potential success of rice coffee muffins in the market. These findings serve as a strong foundation for further research and product development in this area.

Theoretical Framework

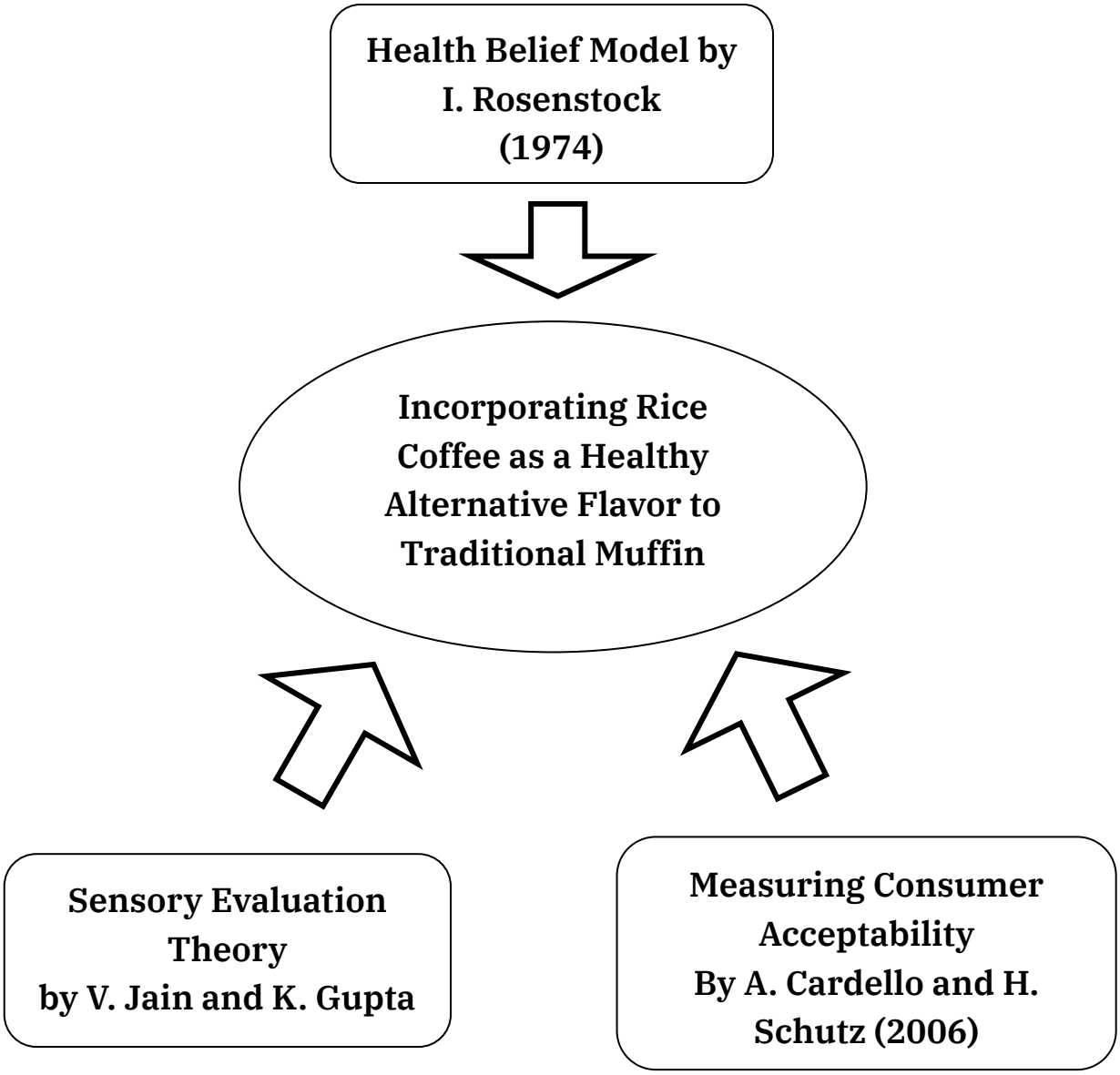

Figure 1. Theoretical Paradigm

The theoretical framework of this study, as shown in Figure 1, is anchored in theme, namely: Health Belief Model by I. Rosenstock (1974), Sensory Evaluation by V. Jain and K. Gupta (2005), and Measuring Consumer Acceptability by A. Cardello and H. Schutz (2006). That can be used as a guide in the study of incorporating rice coffee as an alternative flavor in muffins.

The Health Belief Model (HBM) is a psychological theory that explains why people make health-related decisions and adopt certain behaviors based on their perceptions of risk and benefits. It was originally developed by Irwin Rosenstock in 1974 to understand why individuals engage in preventive health behaviors such as healthy eating, vaccination, and medical screenings. The Health Belief Model (HBM) is directly related to the Statement of the Problem 1 because it explains the factors that influence consumer interest in food choices, including rice coffee muffins. It helps explain why consumers may be interviewed in rice coffee muffins as an alternative. If consumers perceive the health risks of traditional muffins (such as high sugar, gluten, and caffeine) as severe, and they see rice coffee muffins as a beneficial and accessible option, they may be more willing to try them.

Sensory Evaluation Theory aligns with Statement of the Problem 2 because it provides a structured approach to measuring the acceptability of rice coffee muffins based on smell, taste, and texture. This theory emphasizes that food acceptability is determined by human sensory perception, including aroma, flavor, and mouthfeel, which are essential factors in consumer preference. In this study, sensory evaluation will be conducted to assess whether the aroma of rice coffee muffins is appealing, how consumers perceive its taste compared to regular muffins, and whether the texture meets their expectations for a muffin. By applying Sensory Evaluation Theory, the study ensures a scientific and objective assessment of how well rice coffee functions as an alternative muffin ingredient. This will help determine whether rice coffee muffins can be a viable, marketable, and enjoyable alternative to traditional muffins.

Measuring consumer acceptability is crucial in this study as it determines whether rice coffee muffins meet consumer preferences in terms of taste, texture, aroma, and overall appeal. Since food products must be enjoyable for consumers to be widely accepted, this study evaluates how well rice coffee muffins compare to regular muffins. This directly relates to Statement of the Problem 3, which seeks to identify whether there is a significant difference between rice coffee muffins and

traditional muffins. This connection is important because it helps assess whether rice coffee can be a viable alternative ingredient for muffins, providing insights into its potential marketability and acceptance in the food industry.

Conceptual Framework

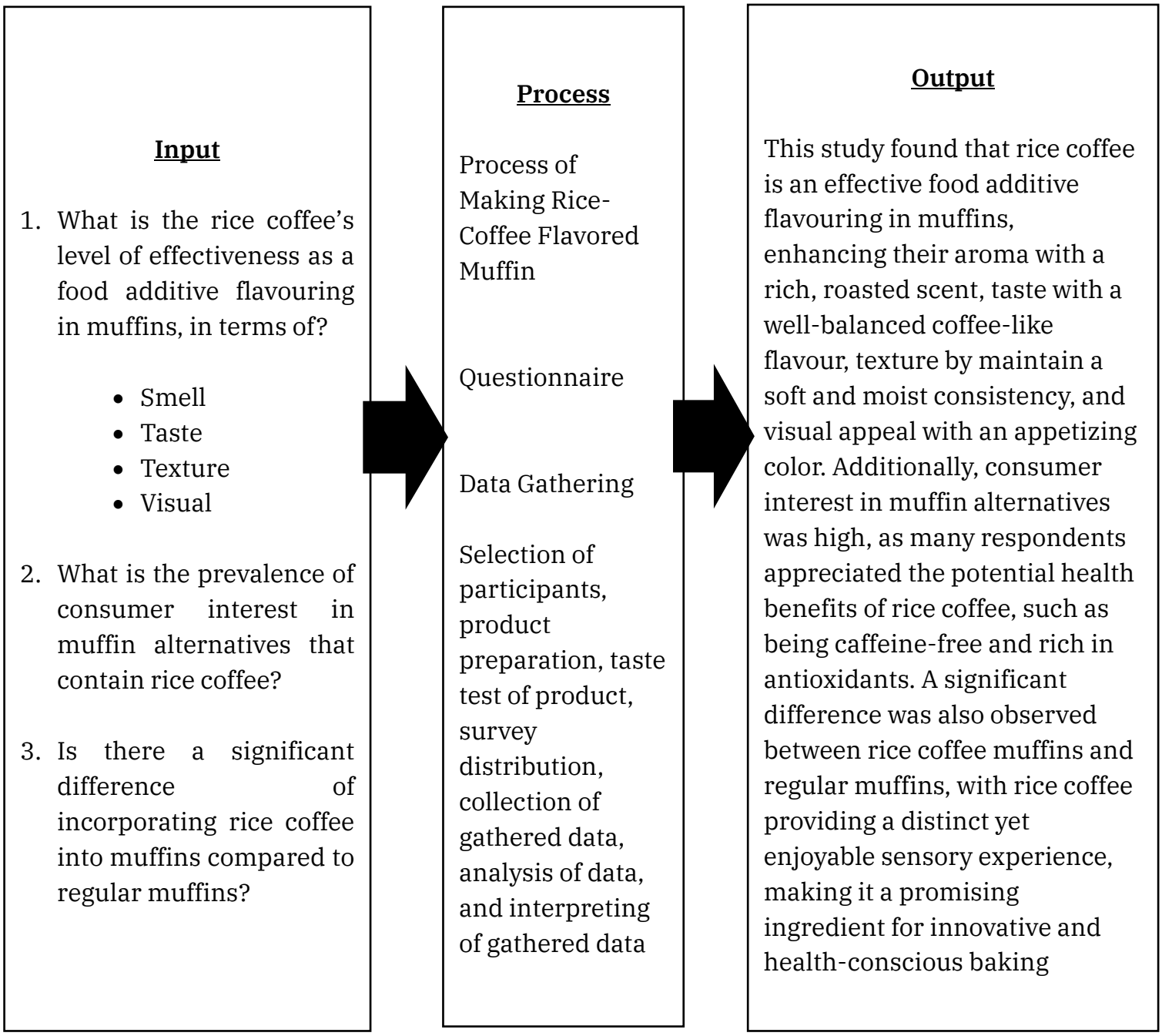

Figure 2. Conceptual Paradigm

The process is composed of the process of making rice coffee-flavored muffin, questionnaires that will be distributed and the process of data gathering such as selection of participants, product preparation, taste test of the product, survey distribution, collecting of gathered data, analysis of data, and interpreting the gathered data. The output of this research is the possible outcome of the study after gathering data from the selected respondents and analyzing and interpreting the collected data.

The input of the study includes evaluating the effectiveness of rice coffee as a flavoring additive in muffins based on taste, smell, texture, and appearance, assessing the level of consumer interest in purchasing rice coffee muffins, and analyzing whether there is a significant difference between rice coffee muffins and regular muffins.

The progress involves producing rice coffee-flavored muffins, developing and distributing questionnaires to the selected respondents specifically senior high school students in STI College, and gathering and analyzing data to assess consumer acceptability.

The output presents the positive findings of this study on the use of rice coffee as a food additive in muffins. It highlights the effects of rice coffee on sensory attributes such as aroma, taste, texture, and visual appeal, as well as consumer interest in alternatives and whether there is a significant difference between rice coffee muffins and regular muffins.

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Chapter III

Methodology

This chapter details the methodology and procedures used in this research. Especially this chapter discusses the research design, population of the study, the sampling method, data collection, and statistical treatment of the data.

Research Design

The researchers will use of a mixed design using the taste testing method, a common method used by the food industry. Comparative design will be used to examine the differences between rice coffee muffins and regular muffins in terms of sensory attributes and it helps to determine whether consumer preferences and acceptance significantly differ between the two types of muffins and regular muffin. Descriptive will be used to evaluate consumer preference in rice coffee muffins based on sensory attributes and it also helps in measuring acceptance levels and muffins without manipulating any variables. Survey will be also used to measure consumer perception and interest in rice coffee muffins using structured questionnaires.

Population of the Study

The population of this study consists of Grade 11 and Grade 12 students from the Senior High School Department of STI College. The researchers will ask 10 volunteers from each section to take part in the study, ensuring a total of 100 Grade 11 and 12 students from the Senior High School Department of STI College as respondents.

Sampling Method

The researchers shall conduct this study at STI College using convenience sampling, selecting Grade 11 and Grade 12 students from the Senior High School Department as respondents. Since convenience sampling is used, anyone who volunteers during the survey shall automatically be included in the study.

Data Collection Procedure

I. Preparation (Rice Coffee Muffin Recipe)

Ingredients

- 1 cup all-purpose flour
- ¾ teaspoon baking powder
- ½ cup muscovado sugar
- ½ cup chopped nuts (e.g., walnuts, almonds, or cashews)
- 2 tablespoon iodized salt
- 1 large egg
- ¼ cup vegetable oil
- 3 teaspoon vanilla extract
- 2 tablespoon rice coffee

Instructions

Prepare the Batter:

- In a mixing bowl, combine all the dry ingredients such as 1 cup all-purpose flour, ¾ teaspoon baking powder, and ½ cup muscovado sugar, 2 tablespoon rice coffee, and 2 pinches of iodized salt.
- Stir until evenly mixed.
- In a separate bowl, combine all the wet ingredient such as 1 egg, ½ milk, 3 tablespoon vanilla, ¼ cup of vegetable oil.
- Once the wet ingredients are mixed, combine it with the dry ingredients and stir.
- Mix the dry and wet ingredients together until you achieve your desired consistency.
- Add the chopped nuts.

Bake the Muffin:

- Preheat your oven to 180 °C.
- Grease a baking pan or line it with parchment paper.
- Pour the prepared mixture into the pan and spread it evenly.

- Bake for 20-25 minutes or until a toothpick inserted in the center comes out clean.

Cool and Serve

- Allow the cake to cool in the pan for a few minutes before transferring it to a wire rack.

II. Data Gathering

The study begins by selecting 100 participants using convenience sampling, with 10 students from each section (ABM 11, STEM A & B, MAWD, and HUMSS for both Grade 11 and 12). Once participants are chosen, the product is prepared, followed by a taste test for the respondents, as outlined in the preparation phase. After sampling the product, a survey is distributed to gather feedback. Finally, the collected data is analyzed to gain valuable insights from the participants' responses.

III. Interpretation

To interpret the gathered data, the researchers intend to use the following statistical tools:

Mean – the sum of all the values in your dataset divided by the number of values. This can help determine the average preference score of the muffins with rice coffee flavor compared to traditional muffins.

Frequency – number of times a particular value or category appears in your dataset. Using this scan show how often participants prefer the rice coffee-flavored muffins over traditional ones. It can also help identify the most common feedback or comments about the new flavor.

Mode – the value or category that appears most frequently in your dataset. The mode can highlight the most frequently given rating or feedback for the rice coffee-flavored muffins.

One-Way ANOVA (Analysis of Variance) – a statistical test used to compare the means of three or more groups to determine if there are significant differences between them. It can help determine if there are significant differences between the ratings or measurements of rice coffee muffins and traditional muffins, such as in taste or texture.

Statistical Treatment of Data

The researchers will systematically compile, categorize, and arrange the data collected. This data will undergo statistical analysis to address the research questions in the study.

To ensure comprehensive data gathering, the researchers will utilize statistical tools, guaranteeing accurate and meaningful results.

The mean will be used to calculate the average acceptability rating of the rice coffee muffins, offering a central value that represents the collective responses from participants. By summing up all the given ratings and dividing by the total number of respondents, the mean provides an overall measure of how the muffins are perceived in terms of taste, texture, or other factors being assessed. For example, if participants rated the muffins on a scale of 1 to 5, the mean would reflect the average level of appeal. This statistical measure is crucial for determining the general sentiment toward the muffins, helping researchers summarize the data into a single, easily interpretable figure. A higher mean would indicate a stronger overall acceptability among participants, making it a key metric for gauging success.

Formula:

$$\bar{x} = \frac{\sum X_n}{n}$$

Wherein:

- X-bar represents the mean (average) of a set of values.
- Σx_n (sigma notation) represents the sum of all individual values (x_1, x_2, x_3, etc.).
- "n" is the total number of values in the dataset.

The mode will pinpoint the most frequently occurring rating in the collected data, revealing the level of acceptability that resonates most with the participants. If, for example, the mode is 4, this suggests that a majority of respondents found the muffins to be highly acceptable. This measure is especially helpful for identifying trends or dominant opinions, as it reflects the shared perception among participants. By emphasizing the most common rating, the mode provides a clearer picture of the muffins' strongest appeal, making it an essential complement to the mean.

Formula:

$$Mode = l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2}\right) \times h$$

Wherein:

- l = lower boundary of the modal class (the class interval with the highest frequency).
- f1f_1f1 = frequency of the modal class.
- f0f_0f0 = frequency of the class before the modal class.
- f2f_2f2 = frequency of the class after the modal class.
- hhh = class width (difference between the upper and lower boundaries of the class).

Percentage and frequency distribution will be also used to this study as it provides a clear and structured way to analyze consumer perception, interest, and preference for rice coffee muffins. By applying this statistical treatment, the study can effectively measure how many respondents actively seek food alternatives, have prior knowledge of rice coffee muffins, and are willing to try or replace regular muffins with this alternative. The frequency of responses allows for an accurate representation of consumer behavior, while percentage distribution helps in comparing data trends and identifying the overall acceptance of rice coffee as a muffin ingredient. Additionally, this method ensures that findings are easy to interpret and visualize, making it an essential tool for assessing market potential and consumer demand.

Formula:

$$Percentage = \left(\frac{Total\ number\ of\ respondents}{Frequency\ of\ a\ response} \right) \times 100$$

Analysis of Variance (ANOVA) is a statistical tool used to compare the means of three or more groups to determine if there are significant differences between them. In this study, ANOVA will be employed to compare the sensory attributes of two distinct muffin types: the innovation Rice-Coffee flavored muffin and the traditional regular muffin. The sensory attributes under scrutiny include aroma, flavor, texture, and overall acceptability. By leveraging ANOVA, the researchers aim to ascertain whether significant differences exist between these two muffin types in terms of their sensory attributes.

Formula:

$$F = \frac{MST}{MSE}$$

$$MST = \frac{\sum_{i=1}^{k} (T^2{}_i / n_i) - G^2/n}{k-1}$$

$$MSE = \frac{\sum_{i=1}^{k} \sum_{j=1}^{n_1} Y^2{}_{ij} - \sum_{i=1}^{k} (T^2{}_i / n_i)}{n-k}$$

Wherein:

1. F-statistic Formula

$$F = \frac{MST}{MSE}$$

- F = Test statistic used to determine if group means are significantly different.
- MST = Mean Square for Treatments (between-group variance).
- MSE = Mean Square for Error (Within-group variance).

2. Mean square for treatments (MST)

$$MST = \frac{\sum_{i=1}^{k} (T^2{}_i / n_i) - G^2/n}{k-1}$$

- k = number of groups
- T_i = total sum of observations in Group III.
- ni = number of observations in Group III.
- G = grand total (sum of all values across all groups).
- n = total number of observations across all groups.

3. Mean square for error (MSE)

$$MSE = \frac{\sum_{i=1}^{k} \sum_{j=1}^{n_1} Y^2{}_{ij} - \sum_{i=1}^{k} (T^2{}_i / n_i)}{n-k}$$

- Y_{ij} = individual observation in Group I, Sample J.
- n – k = degress of freedom for within-group variance.